

1 WHAT IS CLAIMED IS:

2 1. A distance correcting apparatus of a surroundings  
3 monitoring system, comprising:

4 a stereo imaging means for stereoscopically taking a  
5 pair of images;

6 a parallax calculating means for calculating a  
7 parallax based on said pair of images;

8 a distance calculating means for calculating a  
9 distance to an object based on said parallax and a first parameter  
10 for correcting said distance;

11 an approximation line calculating means for  
12 calculating a plurality of approximation lines extending in the  
13 distance direction in parallel with each other based on said  
14 images;

15 a vanishing point calculating means for calculating  
16 a vanishing point of said images from a point of intersection  
17 of said approximation lines; and

18 a parameter correcting means for correcting said  
19 first parameter based on said vanishing point.

20

21 2. The apparatus according to claim 1, further  
22 comprising:

23 a reference object detecting means for detecting a  
24 plurality of reference objects extending in the distance  
25 direction in parallel with each other from a scenery projected

1 in said images and for identifying a position of said reference  
2 objects in an image plane of said images.

3

4 3. The apparatus according to claim 2, wherein  
5 said vanishing point calculating means calculates an  
6 approximation line in said image plane for respective reference  
7 objects, when a plurality of reference objects are detected by  
8 said reference objects detecting means.

9

10 4. The apparatus according to claim 2, wherein  
11 said reference objects are lane markers on a road  
12 projected in said images and when left and right lane markers  
13 are detected on said road, said vanishing point calculating means  
14 calculates an approximation line in said image plane for said  
15 respective left and right lane markers.

16

17 5. The apparatus according to claim 4, wherein  
18 said vanishing point calculating means calculates said  
19 approximation line based on said left and right lane markers  
20 existing within a specified distance range.

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22 6. The apparatus according to claim 4, wherein  
23 said reference object detecting means calculates a  
24 lane marker model expressing the change of a road surface height  
25 with respect to distance and said first parameter correcting means

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1 identifies a condition of change of an actual road surface height  
2 based on said vanishing point calculated by said vanishing point  
3 calculating means, identifies a condition of change of a  
4 calculated road surface height based on said lane marker model  
5 calculated by said reference object detecting means, and corrects  
6 said first parameter so that said condition of change of said  
7 calculated road surface height comes close to said condition of  
8 change of said actual road surface height.

9

10 7. The apparatus according to claim 4, wherein  
11 said reference object detecting means calculates a  
12 lane marker model expressing the change of a road surface height  
13 with respect to distance and said parameter correcting means  
14 identifies a first gradient indicating the change of a road  
15 surface height with respect to distance based on said vanishing  
16 point calculated by said vanishing point calculating means,  
17 identifies a second gradient indicating the change of a road  
18 surface height with respect to distance based on said lane marker  
19 model calculated by said reference object detecting means, and  
20 corrects said first parameter so that a deviation of said second  
21 gradient with respect to said first gradient becomes small.

22

23 8. The apparatus according to claim 4, wherein  
24 said vanishing point calculating means judges whether  
25 or not a lane marker projected in said images is a straight line

1 and in case where it is judged that said lane marker is a straight  
2 line, calculates said vanishing point of said images.

3

4 9. The apparatus according to claim 8, wherein

5 said vanishing point calculating means evaluates a  
6 time-versus change of the position of a lane marker projected  
7 in said images, if said time-versus change is small, judges that  
8 said lane marker has a high reliability as lane markers, and  
9 calculates said vanishing point in said images.

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11 10. The apparatus according to claim 9, wherein

12 said parameter is a vanishing point parallax.

13

14 11. A distance correcting apparatus of a surroundings  
15 monitoring system, comprising:

16 a stereo imaging means for stereoscopically taking a  
17 pair of images;

18 a transforming means for geometrically transforming  
19 said pair of images based on a second parameter indicating a  
20 transference in the horizontal direction;

21 a parallax calculating means for calculating a  
22 parallax based on said pair of images outputted from said  
23 transforming means;

24 a distance calculating means for calculating a  
25 distance to an object based on said parallax;

1           a vanishing point calculating means for calculating  
2 a plurality of approximation lines extending in the distance  
3 direction in parallel with each other and calculating a vanishing  
4 point of said images from a point of intersection of said  
5 approximation lines; and

6           a parameter correcting means for correcting said  
7 second parameter based on said vanishing point.

8

9 12.       The apparatus according to claim 11, further  
10 comprising:

11           a reference object detecting means for detecting a  
12 plurality of reference objects extending in the distance  
13 direction in parallel with each other from a scenery projected  
14 in said images and for identifying a position of said reference  
15 objects in an image plane of said images.

16

17 13.       The apparatus according to claim 12, wherein  
18           said vanishing point calculating means calculates an  
19 approximation line in said image plane for respective reference  
20 objects, when a plurality of reference objects are detected by  
21 said reference objects detecting means.

22

23 14.       The apparatus according to claim 12, wherein  
24           said reference objects are lane markers on a road  
25 projected in said images and when left and right lane markers

1 are detected on said road, said vanishing point calculating means  
2 calculates an approximation line in said image plane for said  
3 respective left and right lane markers.

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5 15. The apparatus according to claim 14, wherein  
6 said vanishing point calculating means calculates said  
7 approximation line based on said left and right lane markers  
8 existing within a specified distance range.

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10 16. The apparatus according to claim 14, wherein  
11 said reference object detecting means calculates a  
12 lane  
13 marker model expressing the change of a road surface height with  
14 respect to distance and said first parameter correcting means  
15 identifies a condition of change of an actual road surface height  
16 based on said vanishing point calculated by said vanishing point  
17 calculating means, identifies a condition of change of a  
18 calculated road surface height based on said lane marker model  
19 calculated by said reference object detecting means, and corrects  
20 said first parameter so that said condition of change of said  
21 calculated road surface height comes close to said condition of  
22 change of said actual road surface height.

23

24 17. The apparatus according to claim 14, wherein  
25 said reference object detecting means calculates a

1 lane marker model expressing the change of a road surface height  
2 with respect to distance and said parameter correcting means  
3 identifies a third gradient indicating the change of a road  
4 surface height with respect to distance based on said vanishing  
5 point calculated by said vanishing point calculating means,  
6 identifies a fourth gradient indicating the change of a road  
7 surface height with respect to distance based on said lane marker  
8 model calculated by said reference object detecting means, and  
9 corrects said third parameter so that a deviation of said fourth  
10 gradient with respect to said third gradient becomes small.

11

12 18. The apparatus according to claim 14, wherein  
13 said vanishing point calculating means judges whether  
14 or not a lane marker projected in said images is a straight line  
15 and in case where it is judged that said lane marker is a straight  
16 line, calculates said vanishing point of said images.

17

18 19. The apparatus according to claim 18, wherein  
19 said vanishing point calculating means evaluates a  
20 time-versus change of the position of a lane marker projected  
21 in said images, if said time-versus change is small, judges that  
22 said lane marker has a high reliability as lane markers, and  
23 calculates said vanishing point in said images.

24

25 20. A vanishing point correcting apparatus of a surroundings

1 monitoring system for taking images of a scenery in front of an  
2 own vehicle and for obtaining a three-dimensional information  
3 of an object projected in said images by making use of an  
4 established vanishing point established beforehand, comprising:

5 reference object detecting means for detecting lane  
6 markers on a road projected in said images and for identifying  
7 a position of said lane markers on an image plane of said images;

8 vanishing point calculating means, when a left and  
9 right lane marker is detected on said road and it is judged that  
10 said lane marker projected in said images is a straight line,  
11 for calculating an approximation line in said image plane for  
12 said respective left and right lane markers and for calculating  
13 a vanishing point from a point of intersection of said  
14 approximation lines; and

15 a vanishing point correcting means for correcting said  
16 vanishing point so that said established vanishing point comes  
17 close to said vanishing point calculated by said vanishing point  
18 calculating means.

19

20 21. The apparatus according to claim 20, wherein

21 said vanishing point calculating means evaluates a  
22 time-versus change of the position of a lane marker projected  
23 in said images, if said time-versus change is small, judges that  
24 said lane marker has a high reliability as lane markers, and  
25 calculates said vanishing point in said images.